Products: SMIQ

Generating Bluetooth™* Signals with SMIQ and the Application Software SMIQ-K5

Application Note

A *Bluetooth* module is a universal radio interface using the license-free 2.4 GHz frequency band. Testing such a radio interface requires data packets as defined in the *Bluetooth* standard. The SMIQ-K5 application software configures the required data packets according to the standard and calculates defined elements of the packet such as the Sync. Word from the Bluetooth Device Address. Configured packets are transmitted along with modulation settings and filter parameters to SMIQ ready to perform a wide range of receiver tests.

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Contents

1 Overview

The concept of the *Bluetooth* standard was developed in the mid 1990s by Ericsson to replace wire cables between information and communication appliances. PCs, computer peripherals (keyboard, mouse, printer, etc.), PDAs, headsets, cameras, laptops and many more would be capable of communicating between each other via the air interface. Communication should occur in ad-hoc network fashion. In 1998 a *Bluetooth* Special Interest Group (SIG) was founded by leading companies working in the communication sector, such as Ericsson, Intel, IBM, Nokia and Toshiba [1]. These five companies played a leading role in defining a *Bluetooth* standard recognized worldwide.

The aim of the SMIQ-K5 software is to enable chip designers and R&D development teams using SMIQ to carry out a wide range of receiver tests defined in the *Bluetooth* Standard, such as receiver bit error rate (BER) tests, sensitivity tests for *Bluetooth* receivers, carrier-to-interference (C/I) performance tests, blocking performance, and intermodulation performance.

2 A Short Introduction to *Bluetooth*

Bluetooth represents a compact near distance radio communication interface. It operates in the world wide license-free 2.4 GHz Industrial, Scientific, Medical (ISM) band [2]. The radio interface works in the range between 2.400 GHz and 2.483 GHz. The existing frequency band is divided in 79 channels. Each of those channels occupies a channel bandwidth of 1 MHz. *Bluetooth* uses Frequency Hopping Spread-Spectrum (FHSS) technology. During a connection, the radio device hops from one channel to another in a pseudo-random fashion. *Bluetooth* is classed as a Time Division Multiple Access (TDMA) system and divides each channel into time slots of 625 µs intervals in the time domain. A communication channel uses a different hop frequency for each slot, leading to a nominal hop rate of 1600 hops/s [3]. Data exchange between devices is in packets. A *Bluetooth* device can transmit either single-slot or multi-slot packets, occupying 1, 3, or 5, time slots. Subsequent slots are alternately used for transmitting and receiving. The modulation is Gaussian Frequency Shift Keying (GFSK), with a symbol rate of 1 MSym/s.

The following table summarizes the RF-characteristics that are defined in the *Bluetooth* standard.

Characteristics	Specifications
Carrier Frequency	2400 MHz to 2483.5 MHz (ISM radio band) 79 Channels[1] Channel Spacing: 1 MHz
Type	TDMA System TDD Bursts FHSS technology 1600 hops/s (hop speed may vary depending on packet length)
Modulation Parameters	• Modulation Type: 2FSK • Symbol Rate: 1Msym/s • Modulation Index: 0.28 to 0.35 (default 0.32) • Max. Freq. Div.: 140 kHz - 175 kHz (default 160 kHz) • Baseband Filter: Gaussian Filter, B*T = 0.5
Transmit Power	Power Class 1: 1 mW (0 dBm) to 100 mW (+20 dBm) Power Class 2: 0.25 mW (-6 dBm) to 2.5 mW (+4 dBm) Power Class 3: 1 mW (0 dBm)
Operating Range	10 cm to 100 m With Power Class 1 devices up to 100 m are achievable
Maximum Data Throughput	The asynchronous channel supports data rates of up to 721 kbps (asymmetric) in either direction while permitting 57.6 kbps in the return direction. 432.6 kbps are possible when the symmetric link is used.

Table 1-1 RF characteristics of the *Bluetooth* standard.

[1] In order to comply with out-of-band regulations, a guard band is used at the lower and upper band edge

- Lower Guard Band: 2 MHz
- Upper Guard Band: 3.5 MHz

3 Software Features

The SMIQ-K5 defines a *Bluetooth* signal setup according to the standard and transmits it to an SMIQ as a set of data and control lists. SMIQ must be configured in such a way, that it uses the data list as data source and modulating it using *Bluetooth* modulation. The modulation parameters can be changed via the SMIQ-K5 software, as well as the power ramping parameters. These parameters either influence the calculation of the data and control lists, or they are transferred to the SMIQ directly by remote control commands.

The SMIQ-K5 greatly assists in creating *Bluetooth* standard packets. With the integrated packet editor it is possible to edit every single information element of the packet, whilst the software calculates defined elements such as Sync. Words or Cyclic Redundancy Check (CRC). Up to now DH1, DH3, DH5, [4] and AUX1 packet types are supported.

The software provides a maximum of flexibility in *Bluetooth* signal generation. It is an ideal tool for conducting BER measurements on Equipment Under Test (EUT) or for testing basic functionality of receivers. As it is only software for signal generation, it does not support either two-way communication or signaling. If signaling with an EUT is required, please refer to the PTW-60 *Bluetooth* protocol tester from Rohde & Schwarz.

Key features of the SMIQ-K5:

- “Data Source for Packet” selector. The data content of the packets can be either defined by the packet editor as a *Bluetooth* standard packet, or the whole packet content is defined by one out of four available data sources.
- Convenient and easy packet configuration of DH1, DH3, DH5, and AUX1 packets with the “Packet Editor”.
- Data packets are simply configured and calculated by using the “Bluetooth Device Address” (BD_ADDR).
- “Packet Editor” shows configuration settings and configuration changes in the data field display immediately. Bit stream representation.
- “Payload Data” configurator. 5 different data sources are available to configure the payload.
- “Packet Repetition” counter, to repeat a configured packet. The payload data content (PRBS 9 etc.) is continued to all subsequent packets accordingly.
- The “Set Power Ramping” function sets power ramping in SMIQ. “Ramping Function” (ramp slope), “Ramp Time”, “Rise Offset” and “Fall Offset”, are set from SMIQ-K5. No extra handling or setting in SMIQ is required.
- All modulation and distortion parameters to set SMIQ into *Bluetooth* modulation are realized and initialized in the software.
- Automatic generation of data and control lists for SMIQ.
- Data and control list handling by SMIQ-K5.

4 Hardware and Software Requirements

Hardware Requirements

The minimum hardware requirements are:

PC requirements running SMIQ-K5:

- CPU: At least Intel x486 CPU. Pentium or higher recommended.
- RAM: 32 MB RAM.
- Monitor: VGA color monitor, minimum resolution at least 800*600 pixels, 1024*768 pixels recommended.
- IEC/IEEE: GPIB (IEC/IEEE)-bus card from National Instruments is recommended and has been tested. A RS232 connection can also be used if no GPIB interface is present.

SMIQ requirements:

- Mandatory: Minimum Requirements: SMIQx equipped with options SMIQB10 (Modulation Coder) and SMIQB11 (Data Generator).
  Standard: SMIQxB models with options SMIQB20 (Modulation Coder) and SMIQB11 (Data Generator).
- Recommended: SMIQB12 (Memory Extension, 32 Mbit) is recommended if a non-truncated PRBS 15 is used with DH1 packets.

  SMIQB21 (BER Measurements).

  SMIQ-Z5 (BNC Adapter for rear panel, D type connector PAR DATA. For Bit Error Rate Testing)

Software Requirements

- Windows 95/98 or Windows NT (version 4.0 or higher).
- GPIB (IEC)-bus driver for Windows from National Instruments.

5 Connecting the Computer and SMIQ

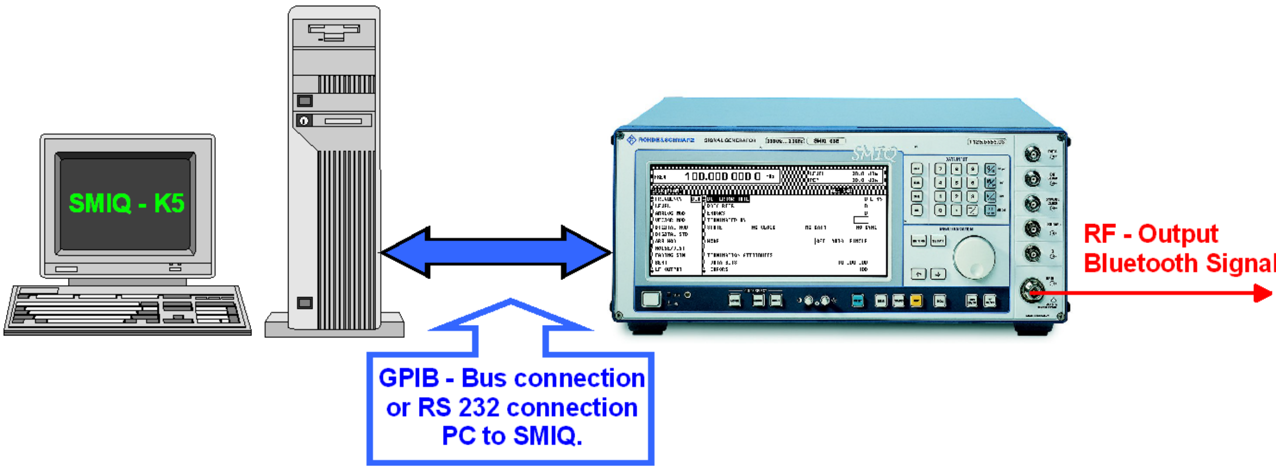

Fig. 5-1 Set-up of PC and SMIQ via GPIB or RS 232 interface link.

1. Connect the PC, which acts as controller, via a GPIB (IEC/IEEE) interface cable or a RS 232 serial link to SMIQ.

Note: *SMIQ-K5 communicates with the SMIQ via the GPIB (IEC/IEEE) bus, the hardware (GPIB card) and driver software for the GPIB card must be installed in the PC. Please refer to the supplier documents for further information on handling and installing the National Instruments card.*

6 Installing the Software

Installation

The SMIQ-K5 uses the LabWindows/CVI Installer from National Instruments. The installation kit for installing SMIQ-K5 consist of 5 files:

- readme.txt
- setup.exe
- smiq-k5.001
- smiq-k5.002
- smiq-k5.003

Readme.txt gives detailed information about the version history of the program. Each version update contains information about improvements in regard to the previous release; a history of bug fixes and brief information about new added features and functions.

The other four files in the set-up kit are necessary to install the SMIQ-K5.

Before installing the software copy all four files to a temporary directory, e.g. c:\temp or c:\Bluetooth.

The Installation is carried out by double-clicking on **setup.exe.** The installation process is fully automated.

De-Installation

De-installation is carried out by selecting “Unistall SMIQ-K5” from the Smiq-k5 program folder in the Windows Start menu.

The icon for the de-installation of SMIQ-K5 is part of the SMIQ-K5 program group. The directory tree is not cleared when it contains user files.

7 SMIQ-K5 *Bluetooth* Settings

The following section describes how to operate SMIQ-K5 in order to configuring a DH1 packet. This is representative for all the other packets that can be configured using the SMIQ-K5. Specific differences in packets are described in detail in the *Bluetooth* Standard [5] documentation and are not explained here.

1. Press the *PRESET* button on SMIQ to set the instrument into starting state.
2. Start SMIQ-K5. The “Main Control” panel will pop up
3. Select **New** in the “File” menu

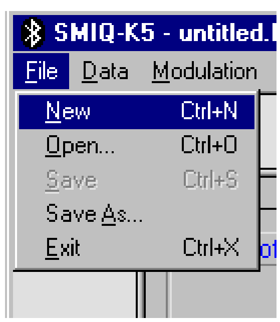

Fig. 7-1 The menu item **New** in **File** opens a new session in the SMIQ-K5

The menu item **New** opens a new session and resets SMIQ-K5 to a default starting state.

4. Click on **Configure Packet**.

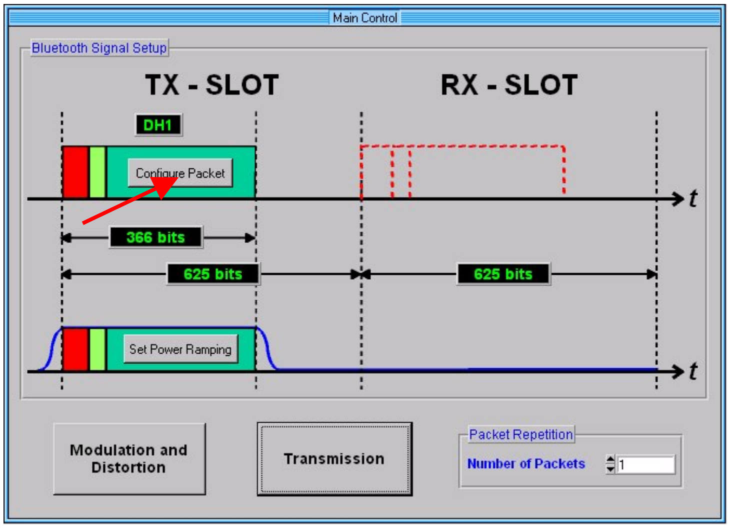

Fig. 7-2 The **Configure Packet** button in the main panel opens the "Packet Type Selector" panel

The "Packet Type Selector" panel will pop up.

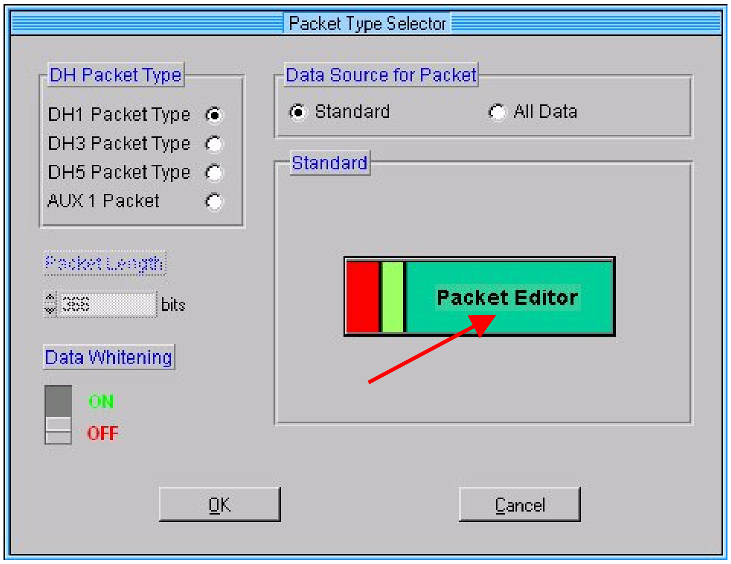

Fig. 7-3 The "Packet Type Selector" panel shows a list of all available data packets that can be configured with the SMIQ-K5. Clicking on the **Packet Editor** opens the packet editor panel.

5. Choose **DH1 Packet Type** as "DH Packet Type".
6. Set "Data Source for Packet" to **Standard**.
7. Check that **Data Whitening** is switched **OFF**.

Note: ***Data Whitening*** *scrambles payload and header to randomize the data from highly redundant patterns and to minimize DC bias in the packet.*

To use an alternative to those packets created out of the Bluetooth standard, click on **All Data**. The “Packet Editor” section will be replaced by the “All Data” section and a list of alternative selections appears, that will form the data stream of the entire packet.

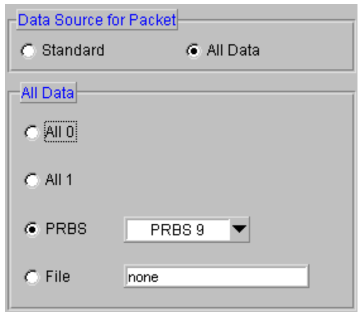

Fig. 7-4 “All Data” offers an alternative to “Standard”. The data stream of the entire packet is formed by one out of four available data sources.

These alternatives are available:

All 0: The data stream of the entire packet consists of logical zeroes.

All 1: The data stream of the entire packet consists of logical ones.

PRBS: The data content of the entire packet consists of a PRBS sequence. The following PRBS sequences are available in the selection list, PRBS 7, PRBS 9, PRBS 11, PRBS 15, PRBS 16, PRBS 20, PRBS 21 and PRBS 23.

File: Select the file containing the packet data. The file extension must be **dbi**.

Note: *For a bit pattern that forms the packet a file in the file section needs to be opened. The file must contain information of ASCII 0 and 1 representation as shown in the editor window in Fig. 7-5. Header information that may be generated as a part of the bit sequence by specific application software such as WinIQSIM™ needs to be erased prior of loading the file into the SMIQ-K5.*

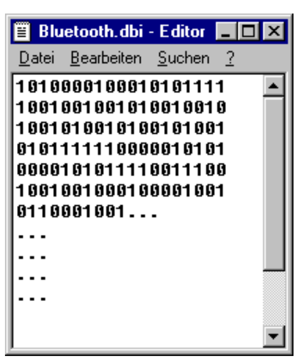

Fig. 7-5 If “File” is selected from the “All Data” list, the content of the file must only contain information of ASCII 0 and 1 representation.

8. Click on the **Packet Editor** button to open the “Packet Editor” panel.

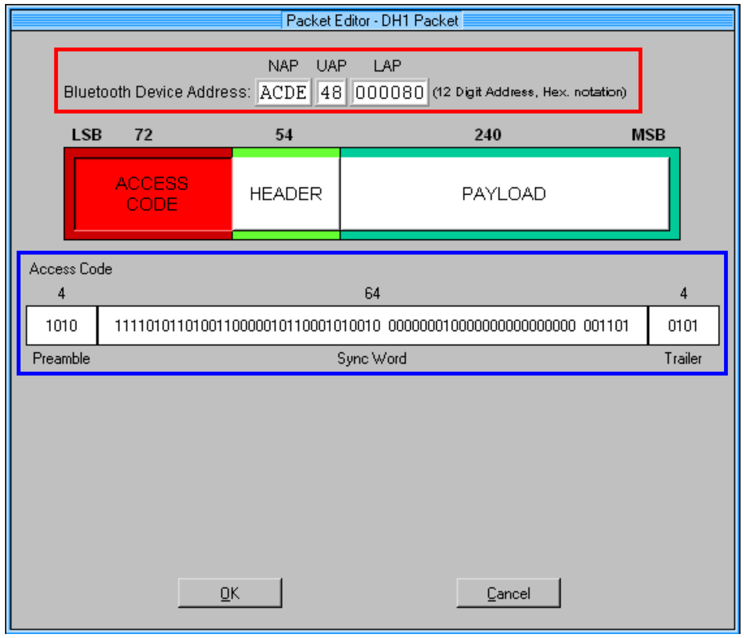

Fig. 7-6 The “Packet Editor” panel shows the DH packet structure. The “Bluetooth Device Address” (BD_ADDR) must be entered at the top of the panel in the three independent section NAP, UAP, LAP for the SMIQ-K5 to calculate the Sync. Word, Preamble and Trailer that will be shown in the “Access Code” display field.

The panel shows a DH1 packet structure with three packet fields:

- **ACCESS CODE field**
- **HEADER field**
- **PAYLOAD field**

9. Click on **ACCESS CODE**.

In the upper half of the window (see Fig. 7-6, box) the user must enter the **Bluetooth Device Address** (BD_ADDR). The address is a 12-digit long hexadecimal number and is divided in three parts:

- NAP - Non-significant Address Part
- UAP – Upper Address Part
- LAP – Lower Address Part

From this address the data stream in each individual packet field is calculated according to the *Bluetooth* standard and displayed in the “Access Code” display field. The lower part of the panel represents the “Access Code” display field and shows the bit representation of the ACCESS CODE. Every change in the BD_ADDR entry field will result in a change of the bit sequence in the “Access Code” display field.

Note: *The Least Significant Bit (LSB) starts at the left end of the individual data field (Preamble, Sync Word, etc.).*

10. Click on **HEADER**.

In the lower part of the panel the "HEADER" display field appears and shows the bit representation of the HEADER code.

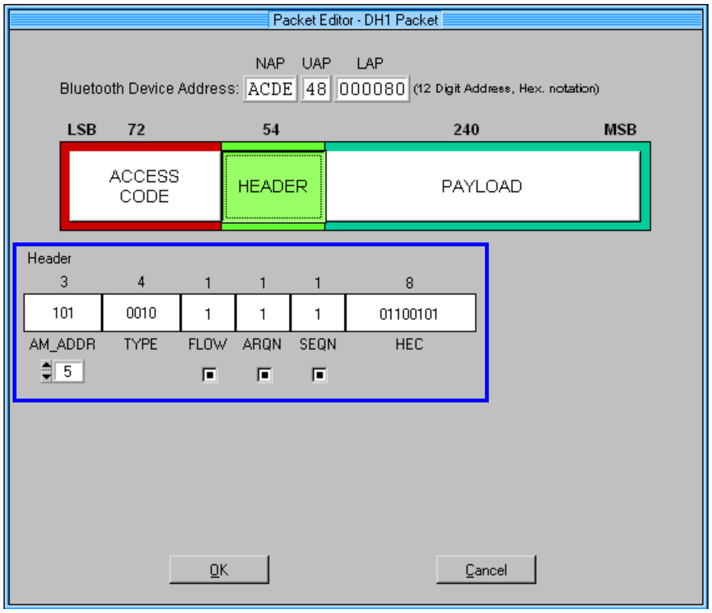

Fig. 7-7 In the HEADER section of the "Packet Editor" panel an AM address (AM_ADDR) from 0 – 7 can be selected and the FLOW bit, the ARQN bit, and the SEQN bit can either be set or un-set.

AM_ADDR The field specifies the member address and distinguishes the active members participating in the piconet. The AM_ADDR can be set in the range of 0 to 7:

- 0 → Reserved for broadcasting packets from the master unit to all participating slaves in the piconet.
- 1,2,...,7 → member address of the slaves in the piconet.

TYPE The field defines the packet type for the two physical links SCO[2] link and ACL[3] link. The different available packets are indicated by the 4-bit TYPE code. For DH1, DH3, DH5 and the AUX1 packet this code is automatically set.

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[2] Synchronous Connection-Oriented (SCO) link. Symmetric point-to-point link between master and a specific slave, which reserves time slots – a forward and return time slot – at regular intervals.

[3] Asynchronous Connection-Less (ACL) link. Is a point-to-multipoint link between master and slave. For ACL link no time slots are reserved like for the SCO link.

FLOW

The field is responsible for the flow control of packets in the ACL link.

- FLOW = 0: Transmission of data is stopped temporarily when RX buffer is full.
- FLOW = 1: Transmission of data is continued when RX buffer is empty.

ARQN

This field is responsible for acknowledgment indication. It is used to inform the source of a successful transfer of payload data with Cyclic Redundancy Check (CRC).

- ACK (ARQN=1) is returned, when reception was successful.
- NAK (ARQN=0) is returned if reception was not successful.

SEQN

SEQN toggles to order the data packet stream. For each new transmitted packet that contains data with CRC, the SEQN bit is inverted. This is required to filter out retransmissions at the destination.

Note: *SMIQ-K5 automatically includes the inverted bit for each consecutive packet transmitted to the SMIQ.*

HEC

Each header has a header-error-check to check the header integrity.

Note: *The Least Significant Bit (LSB) starts at the left end of the individual data field (AM_ADDR, Type).*

11. Click on **PAYLOAD** to finalize the packet type configuration.

In the lower part of the panel the "PAYLOAD" display field appears and shows the bit representation of the PAYLOAD code.

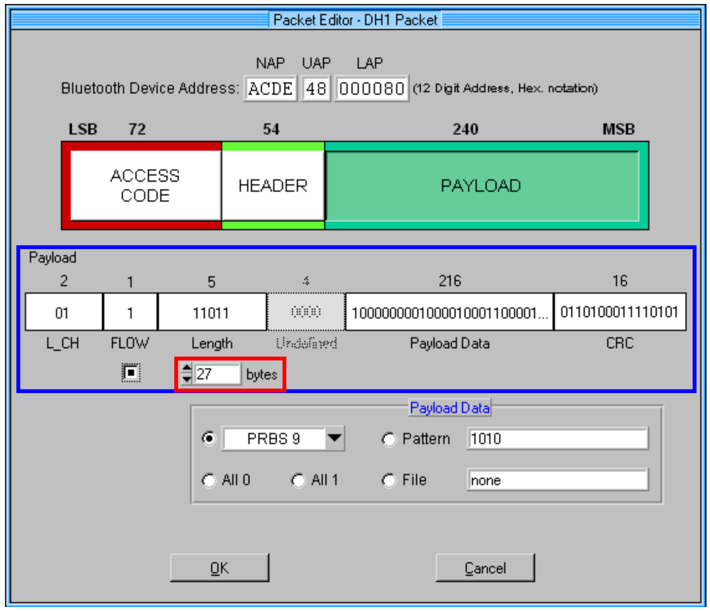


Fig. 7-8 The “PAYLOAD” section of the “Packet Editor” panel. The Length information field describes the number of transmitted information octets (8 bit) in the Payload Data field.

The PAYLOAD field separates the code parts in three segments:

- **Payload Header**
- **Payload Body**
- **CRC Code**

PAYLOAD HEADER

DH1 and AUX1 packet types have a 1-byte payload header. All the other packets use a 2-byte long payload header.

L_CH

L_CH specifies the logical channel. A L2CAP message can be fragment into several packets.

- CODE 10 is used for a L2CAP packet carrying the first fragment of such a message.
- CODE 01 is used for continuing fragments.

If there is no fragmentation, code 10 is used for every packet.

FLOW

The field is responsible for the control of the flow at the L2CAP level. It is used to control the flow per logical channel (when applicable).

- FLOW = 0: flow-off (“stop”)
- FLOW = 1: flow-on (“OK to send”)

Length

The field describes the number of transmitted information octets (8-bit) in the **Payload Data** field (payload header and CRC are excluded). The length information is either 5 bits for DH1 and AUX1 packets or 9 bits for DH3 and DH5 packets.

Note: *The Undefined field is reserved for later purposes. It has currently no function.*

PAYLOAD BODY

The **Payload Data** field in Fig. 7-9 is filled by one of the following data sources:

- a PRBS sequence selected in the PRBS type selector
- a user defined pattern
- pattern all 0
- pattern all 1
- a user defined file. The file must contain information of ASCII 0 and 1 as shown in Fig. 7-5. The file is read out cyclically as all the other data sources. The file extension is specified as **dbi**.

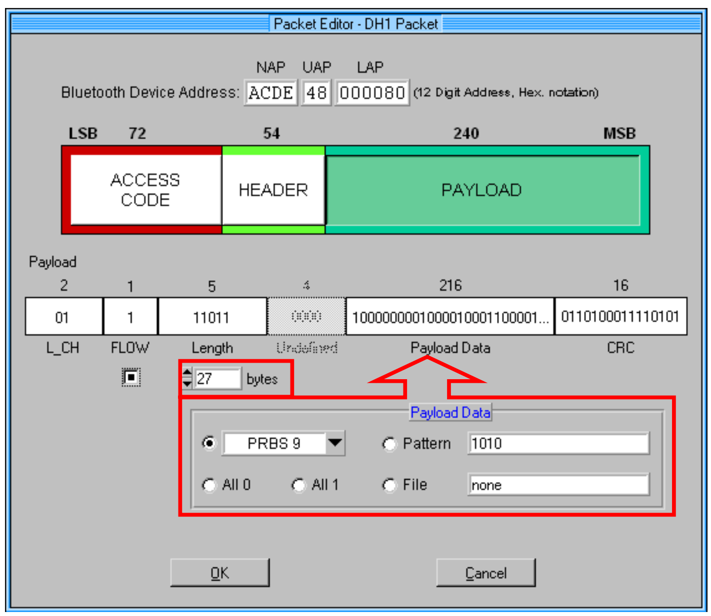


Fig. 7-9 The content of the "Payload Data" field is formed by one out of five available data sources.

Note: *The data stream of type PRBS or a pattern or a file data source is continued in the payload field of the next packet.*

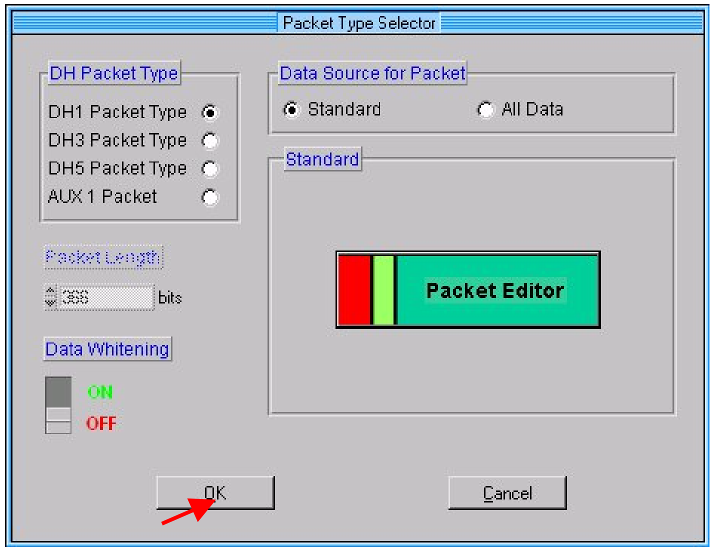
CRC

A 16 bit Cyclic Redundancy Check (CRC) is used to protect the entire payload field and therefore enable error detection. The register is initialized with the UAP of the Bluetooth Device Address.

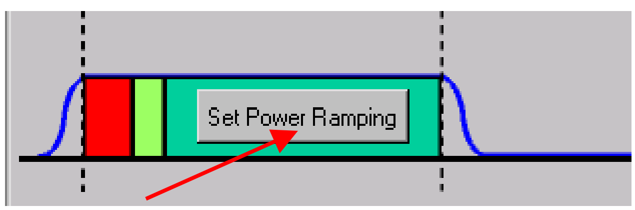
Note: *The CRC is not used for AUX1 packets.*

12. Set Payload Data to **PRBS9**
13. Check if the Length of the Payload is set to **27**-bytes
14. Click **OK**, to leave and close the panel.

Note: *The Least Significant Bit (LSB) starts at the left end of the individual data field (Length, Payload Data, etc.).*



15. Close the "Packet Type Selector" panel by clicking **OK**.



16. Click on **Set Power Ramping**[4], if you need to adjust the ramping condition. The "Power Ramp Control" panel will pop up. Power ramping allows you to set, ramp function (ramp slope), ramp time, rise and fall offset.

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[4] A detailed explanation of how to use the Power Ramp Control panel is given in the program's online-help.

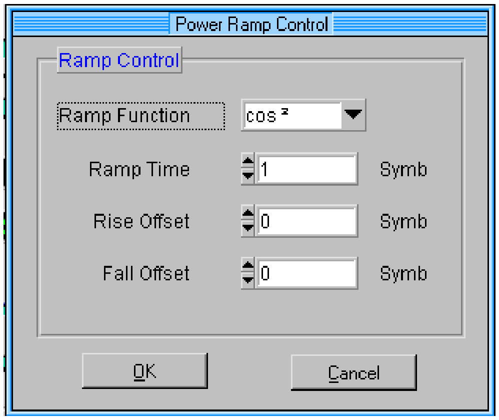


Fig. 7-10 In the “Power Ramp Control” panel the characteristics of the power ramp can be set for burst control of the packet.

Note: *The settings in the “Power Ramp Control” panel are needed for the calculation of the data and control lists. The “Rise Offset” and “Fall Offset” are set in the control list in the SMIQ, whereas “Ramp Function” and “Ramp Time” are set in the “Power Ramp Control...” menu in the SMIQ. Changes to “Rise Offset” and “Fall Offset” require a re-transmission of the lists to the SMIQ and is not immediately changed upon alteration.*

The parameters “Ramp Function” and “Ramp Time” are also necessary to be transferred to the SMIQ as well as remote settings. This is done at the time of list transmission if the "Automatically switch on Modulation after Transmission" parameter is set in the “Preferences...” dialogue of the SMIQ-K5. Select “Transmission/SMIQ” from the main menu bar or alternatively select “Activate Lists” in the “Transmission” panel.

Fig. 7-11 To activate the burst control immediately after list transmission, “Automatically switch on Modulation after Transmission” in the “Preferences...” menu should be check marked.

17. If you have selected “Power Ramp Control”, you can close the panel by clicking on **OK** button. Otherwise press **Cancel** if changes should not apply to your signal setup.

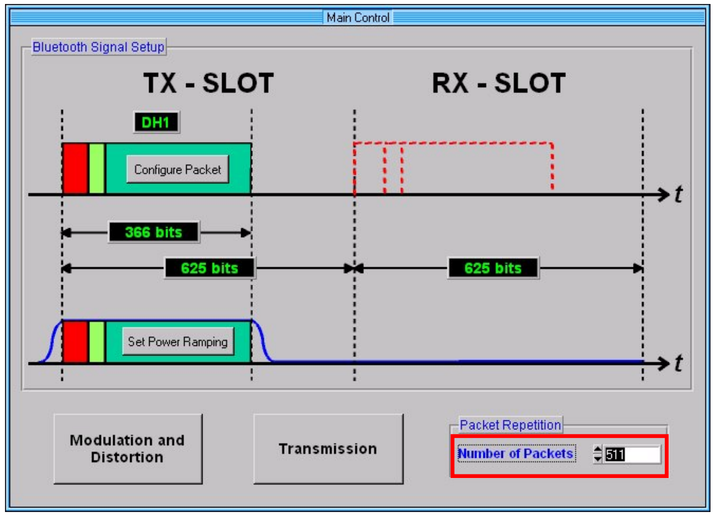


Fig. 7-12 In the “Packet Repetition” field of the “Main Control” panel the number of packets transmitted to the SMIQ is entered.

18. Enter the number of packets you want to transmit to the SMIQ in the “Packet Repetition” field.

Note: *For BER measurements with non-truncated PRBS9 sequences set the packet repetition counter to **511** packets.*

19. Click on the **Modulation and Distortion** button to open the “Modulation Settings” panel alter all modulation settings if necessary.

- Check if the modulation parameters are correctly set. Alter as necessary.
- Press the **RESET** button if modulation parameters should be set back to default conditions.

Default Conditions:

- Modulation Type: 2FSK
- Frequency Deviation: 160 kHz
- Symbol Rate: 1 MHz (Symbol Frequency)
- Modulation Index: 0.32
- Filter Function: Gauss
- B*T: 0.5

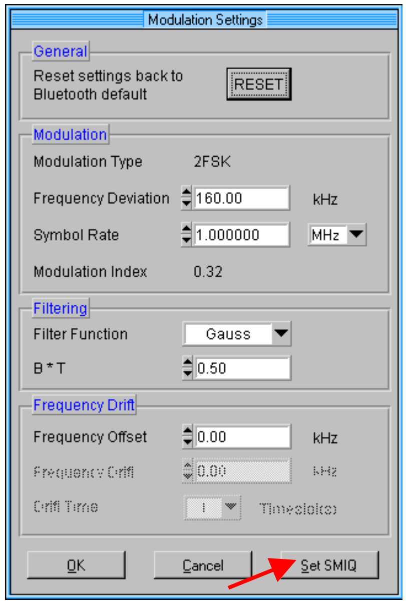
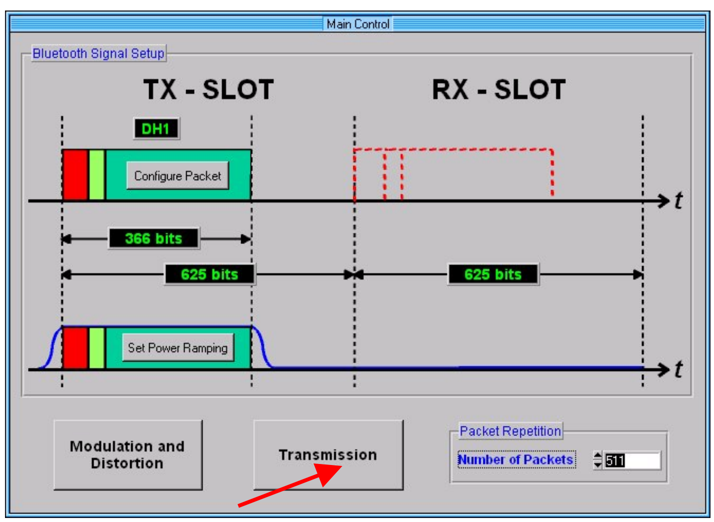


Fig. 7-13 In the “Modulation Settings” panel all necessary modulation settings can be comfortably done in the software and immediately transferred to the SMIQ.

Press **Set SMIQ** to transfer the current modulation settings to SMIQ. Use this button, to apply your changes made in the panel immediately. The buttons “OK” or “Cancel” on the other hand do not affect the modulation settings in the SMIQ.

20. Click on **OK** button to leave the panel.



21. To transfer your configured packets to the SMIQ, press the **Transmission** button in the main panel of SMIQ-K5.

The “SMIQ Data/Control List Transmission” panel opens.

22. Press **Select Lists** button in order to define a new list.

The “Select Destination Data List for Transmission” panel opens.

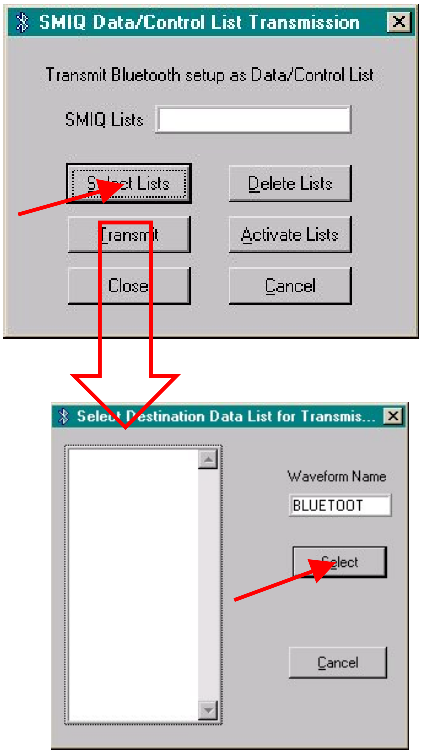


Fig. 7-14 The SMIQ-K5 can either transmit a new created data and control list to the SMIQ or the software offers the possibility to select a data and control list from a pool of already stored lists on the SMIQ.

23. Enter a name in the “Waveform Name” field, e.g. BLUE or choose an existing list from the table of the left half of the window.

24. Press **Select** button

Pressing the **Select Lists** button shows the currently available lists in the SMIQ. One of these lists can be selected in the table window, or a new list name can be entered in the “Waveform Name” field. Lists are selected and will appear in the “Waveform Name” field when pressing the **Select** button.

Activate Lists button selects the pair of lists entered in the “SMIQ Lists” field, transfers all settings made in the modulation and power ramping panels and activates the modulation with these settings. This function reuses an already transmitted pair of lists, without having to undergo all the calculation and transmission phase again. Please make sure that the changes made by the settings apply to the list pair you have selected.

When the ramp time parameter in the power ramping panel has been changed, a complete retransmission is absolutely necessary. Otherwise you might get an incorrect ramping behavior.

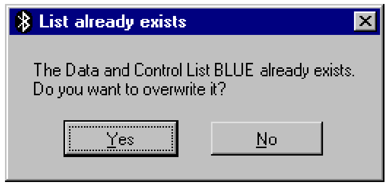


Fig. 7-15 A warning message is issued if one tries accidentally to overwrite an already stored list on the SMIQ.

Note: *Existing data lists and control lists with a name already stored on the SMIQ will be overwritten. Prior to overwriting the lists a warning message is issued preventing you from accidentally overwriting existing lists.*

25. Finally click on **Transmit**

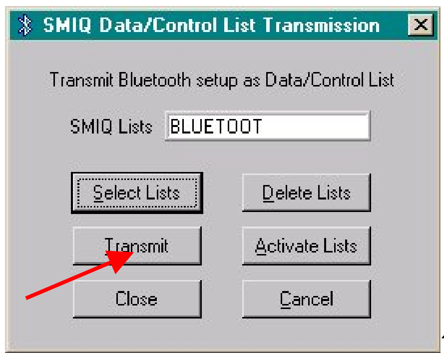


Fig. 7-16 Pressing "Transmit" button, the set of lists with the list name displayed in the "SMIQ Lists" will be transmitted and stored on SMIQ.

26. Press **Close** to leave the panel.

The data and control lists are transmitted to SMIQ and sets the SMIQ to *Bluetooth* modulation immediately after transmission, if in the "Preferences..." dialog box under "Transmisson/SMIQ", "Automatically switch on Modulation after Transmission" is check marked.

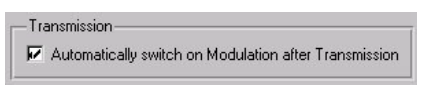


Fig. 7-17 To activate the modulation immediately after list transmission, "Automatically switch on Modulation after Transmission" in the "Preferences..." menu should be check marked.

Otherwise you have to activate the lists manually by clicking on "Activate Lists"

SMIQ now produces a DH1 Packet with a PN9 sequence as payload.

8 Mask Signals for BER Measurements

To perform Bit Error Rate (BER) measurements, the data sequence of the transmitted packet needs to be masked, as the data stream of the *Bluetooth* signal also contains other data information in the frame structure than PRBS data [6]. A marker signal in the SMIQ control list needs to be set to mask only the “Payload Data” field in the “PAYLOAD” (see Fig. 8-1). This mask signal is provided in the control lists as a trigger signal. The trigger signal is available at the PAR DATA interface connector at the rear panel of SMIQ.

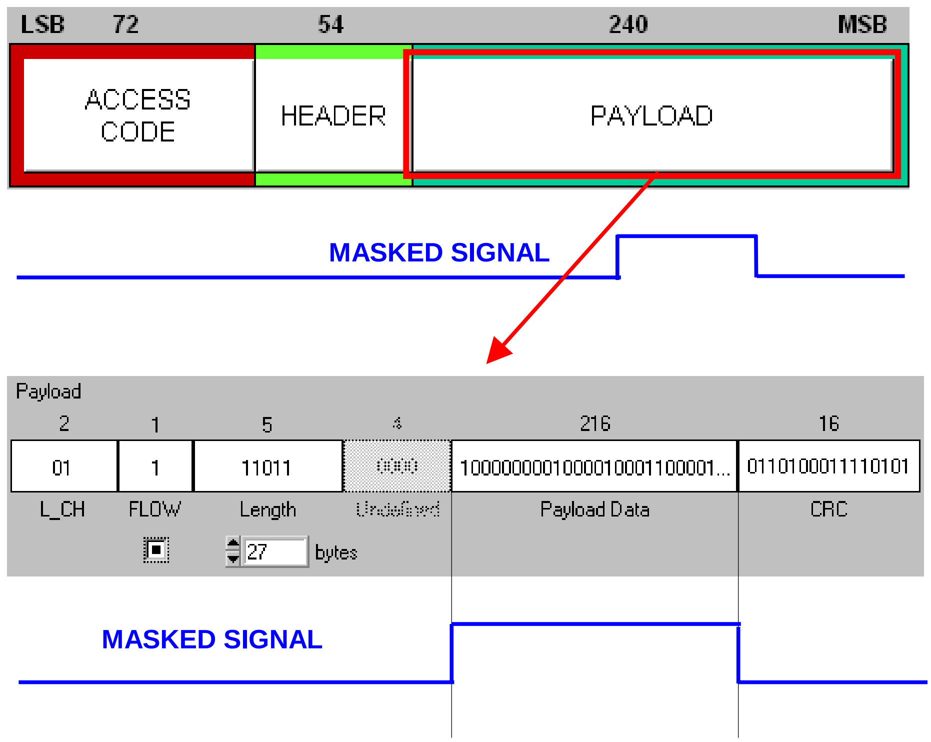


Fig. 8-1 The masked signal for performing BER measurements masks the “Payload Data” field and is provided at the PAR DATA[5] interface connector at the rear panel of SMIQ.

Bit Error Rate tests with SMIQ are only possible if SMIQ is equipped with option SMIQB21 [7]. Otherwise an external BER tester is necessary. An SMIQ-Z5 extension board is recommended to obtain the trigger signal for masking the data. The extension board is fitted with BNC connectors and therefore no additional cabling has to be prepared for connecting the mask signal to the BER tester. If the SMIQ BER tester is installed an appropriate cable is provided with the option. Simply connect the BNC cables as shown in the set-up diagram, Fig. 8-2.

[5] The mask signal for the payload is output at pin 11 (TRIGOUT 1) at the PAR DATA interface.

Note: *In the control list a second trigger signal is set that represents a mask signal over the entire packet. This mask signal is especially useful for packets that use PRBS sequences over the entire packet length. Since the RX slot is filled with dummy bits as dummy data (in the SMIQ-K5 those dummy bits are logical 0) the useful part of the transmitted data stream to the SMIQ needs to be masked.*

The trigger signal is available at TRIGGER OUT 2[6] *BNC connector from the Z5 extension board.*

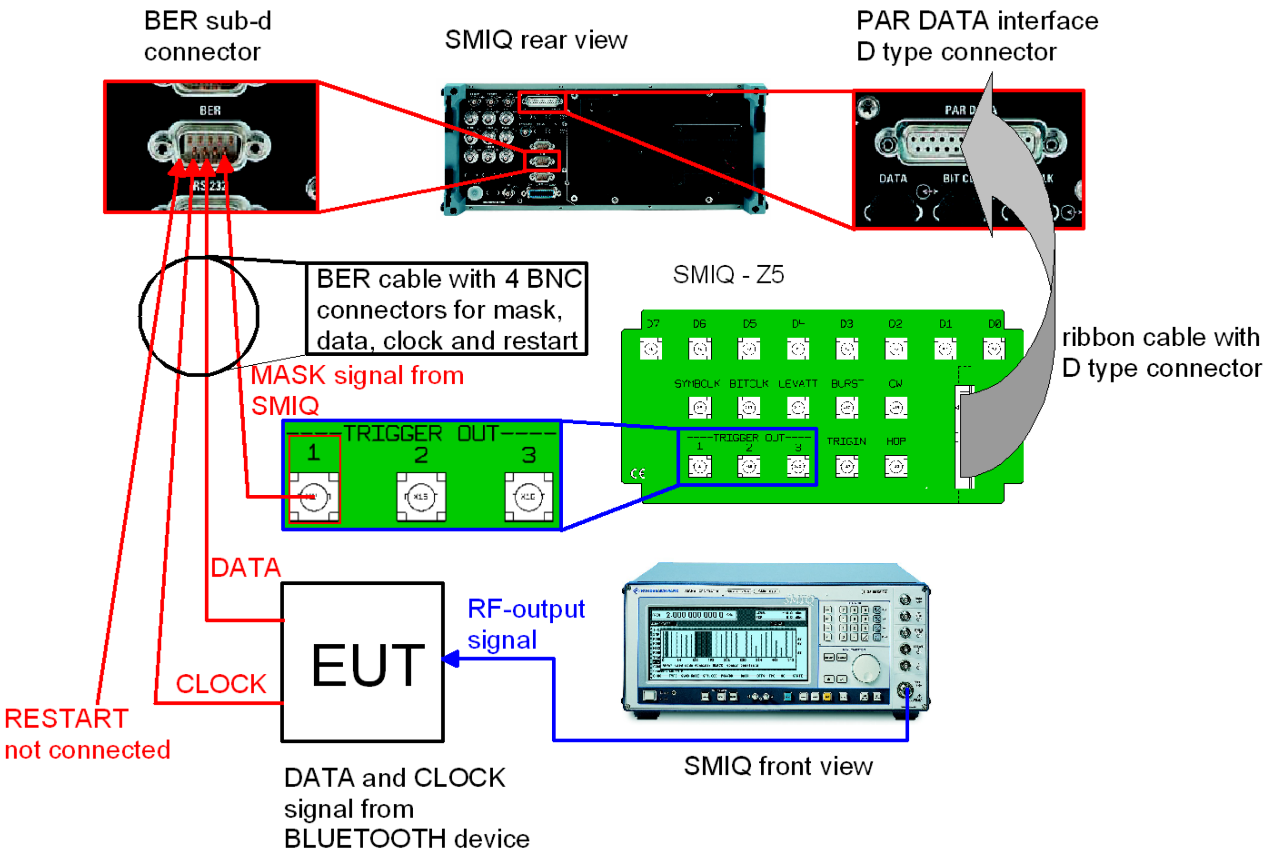


Fig. 8-2 Connection plan for BER test set-up for a *Bluetooth* device with mask signal provided from the SMIQ.

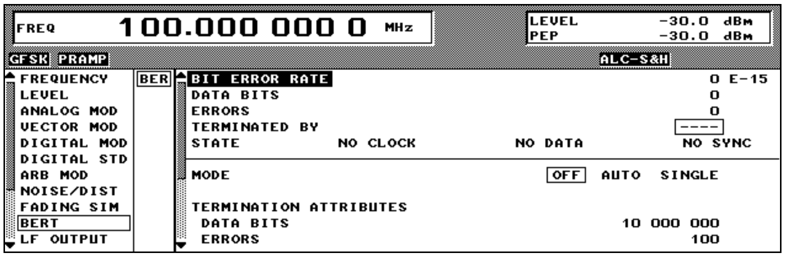
Note: *In cases, where an EUT has no clock signal or can not provide a clock signal, SMIQ can be used to supply the clock signal for the BERT. The clock signal is simply taken from the BNC output* ***BIT CLOCK*** *at the front panel of the instrument. The part of the BERT cable, which is labelled with CLOCK is connected to the BIT CLOCK.*

[6] The mask signal for the entire packet is output at pin 23 (TRIGOUT 2) at the PAR DATA interface.

Demonstrating the Bit Error Rate Tester (BERT) Option SMIQB21 in SMIQ.

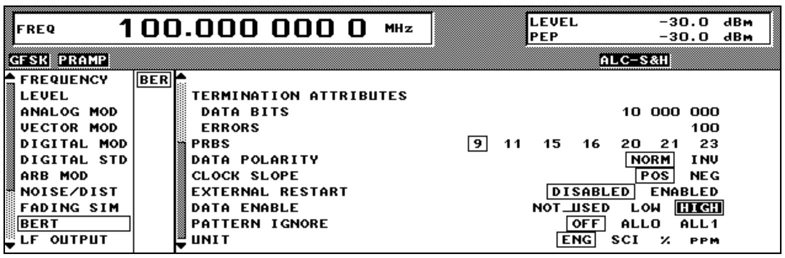
This demonstrates internal BER measurements with the SMIQ equipped with option SMIQB21.

1



1. Scroll with the rotary knob to menu *BERT* and select *BER* with the *SELECT* hardkey

2

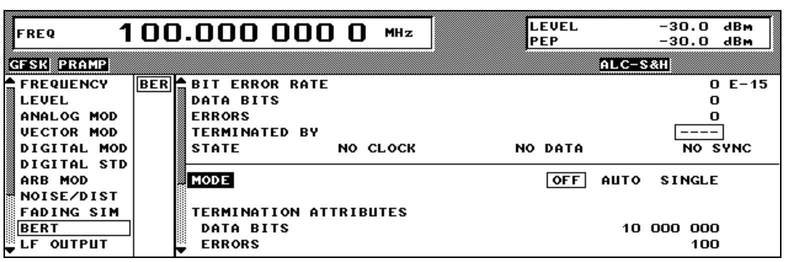


2. Scroll down to submenu *DATA ENABLE*
3. Select from the three available options the entry *HIGH*

To activate the MASK signal that has been set in the control list and is output from the TRIGGER OUT 1 BNC socket.

4. Check if *PRBS* type is set to *9*
5. Leave the other settings unchanged

3

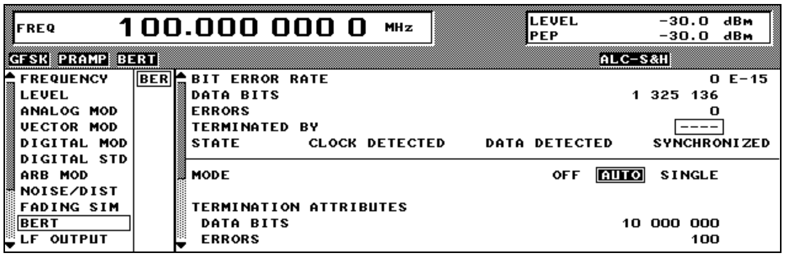


6. Define the *TERMINATION ATTRIBUTES*

The *TERMINATION ATTRIBUTES* define the termination criteria for the measurement.

- *DATA BITS:* termination criteria is “Number of transmitted data bits”
- *ERRORS:* termination criteria is “Number of detected errors”

7. Scroll now with the rotary knob up to *MODE* and select *AUTO*

4 

AUTO activates the continuous measurement mode for bit error rate testing. If one or both criteria for termination are fulfilled, a new measurement is initiated automatically. Depending on the settings made, a measurement may take considerable time. During the first measurement, intermediate results are displayed. For the measurements that follow, only the final results are shown. The parameters *DATA BITS* and *ERRORS* are continuously updated and indicate the relative values for the measurement in progress.

9 Literature

[1] D. Mahnken: *Bluetooth – a global standard for wireless connectivity*, Rohde & Schwarz (1999)

[2] J. Haartsen: *BLUETOOTH - The universal radio interface for ad hoc, wireless connectivity*, Ericsson Review **3**, 110 (1998)

[3] R. Desquiotz: *Creating Test Signals for Bluetooth with AMIQ/WinIQSIM and SMIQ*, Application Note 1GP38_0E, Rohde & Schwarz (1999)

[4] D. Liebl: *Generating Bluetooth^{TM} RF Test Signals With SMIQ Signal Generator*, Application Note 1MA31_0E, Rohde & Schwarz (2001)

[5] *Bluetooth* specification 1.1: *The Bluetooth System* (Draft V1.1 – October 6, 2000)

[6] R. Desquiotz: *Bit Error Rate Measurements with AMIQ and WinIQSIM*, Application Note 1GP36_0E, Rohde & Schwarz (1998)

[7] Vector Signal Generator SMIQB, Operating Manual, PD 1125.5610.12 Rohde & Schwarz (2000)

10 Ordering information

Vector Signal Generator:		
SMIQ02B	300 kHz to 2.2 GHz	1125.5555.02
SMIQ03B	300 kHz to 3.3 GHz	1125.5555.03
SMIQ04B	300 kHz to 4.4 GHz	1125.5555.04
SMIQ06B	300 kHz to 6.4 GHz	1125.5555.06
Options:		
SMIQB11	Data Generator	1085.4502.04
SMIQB12	Memory Extension	1085.2800.04
SMIQB20	Modulation Coder	1125.5190.02
SMIQB21	BER Measurement	1125.5490.02
Recommended extras:		
SMIQ-Z5	BNC Adapter for rear panel, D type connector PAR DATA.	1104.8555.02

SMIQ-K5 is available free of charge on the Rohde & Schwarz website, Internet: http://www.rohde-schwarz.com

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